

mixed first and second; this will give some idea of what the cost will be.

After Munich the regular trains may be relied on; one can leave Munich at 9.50 P.M. (first and second class), pass Innsbruck, and crossing the Brenner in the early morning descend the Italian side in the forenoon, getting to Verona at 1.20 P.M.; or by leaving Munich at 10.15 A.M. (first, second, and third class) one may get to Verona at 5.50 A.M. next day; but in this way one misses the best of the scenery. The fares from Munich to Verona are about 37s., 25s., and 18s.

The way, then, is to Padua, Bologna, Pistoia, and so either to Florence or to Leghorn (by Pisa); from Florence to Rome, passing by Lake Trasimene; from Leghorn to Rome by the coast line, or else straight to Messina or to Naples, and then to Messina, by one of Rubattino's boats, which leave almost daily. From Rome one goes to Naples by train, and thence by boat to Messina, passing close to Stromboli. Some of the boats go on to Catania, but it is advisable to land at Messina and take the train, as often the steamer cannot get into the harbour at Catania, in which case it goes on to Malta. The railway fares from Verona to Naples come to about £4 10s. first; £3 5s. second; and £2 5s. third class.

By travelling *almost incessantly* one should (supposing the trains regular) get to Naples from London in five days and six nights by this route: no time is lost by spending a night at Cologne.

At Messina, the Custom House authorities are usually rather troublesome, but one does get off at last, and, passing along a most exquisite coast-line, arrives at Catania (*Kar' Atyvri*).

The hotel at which to stay, if possible, is the Grande Albergo, kept by Herr Werdenberg, where there is every comfort, the very small salon being redeemed by the fine billiard-room. The front rooms face towards the north, and are cold and unsuited for invalids, but they (especially those of the third story) afford a most splendid view of Etna, the sunrises and sunsets seen from them being superb. The rooms at the back are much warmer, but of course give no sight of Mongibello. The Grand Hôtel Central is an Italian establishment in the Piazza dell' Università, and may be considered to be the second, though much inferior to the first-mentioned house.

In Catania itself a good post of observation would probably be the Giardino Bellini on the Corso; it is high and sufficiently large.

To go to Nicolosi a two or three-horse carriage is necessary. There are at this village two inns, one at the entrance to the village (not to be recommended), the other one, which is preferable, farther on in the village. The accommodation is of a very primitive description. Everything should be taken from Catania, as little can be got at Nicolosi.

From Nicolosi one can visit the Monti Rossi (in half-an-hour or three-quarters), from which one has a magnificent view, and one can, if one is curious enough, go down into a hole, known as the Fosse dei Palumi, a volcanic vent.

It is from Nicolosi that the ascent of Etna is made, and a description of an ascent, under especially favourable circumstances, will be found in the number of NATURE for June 23 last.

The best guide is Pietro Cravagna, who knows the mountain thoroughly, and who also speaks tolerable Italian; he is in every way to be trusted, and if another guide be necessary, it will be well to let Pietro find him. The writer was on one occasion subjected to great annoyance from the incompetence of one of the so-called guides.

The Casa del Bosco, about two-and-a-half-hours' ride from Nicolosi, is uninhabited during the winter. A fire of sticks may be made there, and a few plates, &c., will be found; the key must be got at Nicolosi; there is plenty of good water close at hand. This house might be used for purposes of observation; it has two rooms, and an outhouse for the mules.

The Casa degli Inglesi, near the top of Etna, is almost sure to be buried in the snow.

In descending from the summit it may perhaps be possible to go down into the Valle del Bove, and return to Catania by Zafarana. Those who visit Sicily should not return home without stopping a day or so at Taormena (between Catania and Messina), and seeing a sunrise from the ruins of the theatre.

W. H. C.

The Spectrum of the Aurora

As some of your correspondents seem scarcely aware of what has already been accomplished in observation of the auroral

spectrum, perhaps I may be pardoned a few remarks on the subject.

The line usually most prominent in the auroral spectrum is a yellowish green one, the wave-length of which was measured by Angström as 5567, and its position by Professor Winlock as 1280 on Huggins' scale, which, reduced to wave-length, closely agrees with the determination of Angström.

Angström also observed the same line in the spectrum of the zodiacal light, in March 1867, but it seems possible it might be due to faint aurora concealed by the light. He says that "it is a remarkable fact that this bright band does not coincide with any of the known rays of simple or compound gases which I have as yet examined." The wave-length of H β is about 4862; much less than that of the auroral line. Angström also saw three very feeble bands near H β (F).

Professor Winlock (*American Journal of Science*, Nov. 1869,) states that in addition to the line at 1280 Huggins' scale, he saw six faint bands, viz., at 1400, 1550, 1680, near F, 2640, and near G.

In the *American Journal of Science*, Sept. 1869, it is stated that during the solar eclipse a bright line was seen in the spectrum of the corona at 1474 of Kirchhoff's scale, and that it coincided with an auroral line. 1474 Kirchhoff corresponds to about 1550 Huggins' scale.

I have also somewhere seen it stated that the auroral line at 1280 coincided with a telluric line in the sun's spectrum, which might be possibly due to oxygen.

I have myself seen several feeble bands between the green line and F, but owing to their faintness have not yet been able to determine their position with much accuracy.

The red line which was so bright in the aurora of the 24th and 25th ult. is only occasionally visible. Mr. T. W. Backhouse has observed it repeatedly, and informs me that it is sometimes visible when the aurora does not appear red to the eye, but that he never recollects seeing it when some part of the sky was not red. This quite agrees with my own experience. As your correspondent, "T. F." observes, the red line probably belongs to a spectrum distinct from that of the green line, and may be due to some other gas. It may, however, be only a fresh line of the same gas due to different temperature. Its position from repeated direct comparison is about $\frac{1}{4}$ of the distance from H α to Na. as I stated a week or two since. It is, therefore, not identical with H α , to which the ordinary red light of ignited hydrogen is due.

Changes of pressure and temperature do not affect the position of lines, but merely influence their breadth and intensity, making new lines visible and expanding old ones. Sometimes, as in the well-known case of nitrogen, an entirely fresh spectrum is produced; but while any line remains visible its position is unchanged. Hydrogen gives several such spectra, but I believe none of them have a line in the position of the auroral one.

I am at present engaged in a little research on the spectra of certain gases in relation to that of the aurora; but it is not yet sufficiently advanced for publication.

It is particularly desirable that the positions of lines should be accurately determined. In the case of the aurora I am acquainted with no better method for doing this than by comparison with such a spectrum as the band spectrum of N. This is a most convenient natural scale, with thirty or forty brilliant bands; and may readily be obtained from a small tube containing rarefied air or nitrogen, by the aid even of a Ruhmkorff's smallest coil.

With regard to the spectroscope, a simple flint glass prism fitted to a tube carrying an adjustable slit, and without any lenses, gives a brighter spectrum than any other form of instrument that I am acquainted with.

HENRY R. PROCTER

Clementhorpe, North Shields, November 12

The November Meteors

ON the nights of the 12th, 13th, and 14th of November the sky was constantly watched from 5 P.M. to 7.30 A.M. The weather throughout was most unfavourable.

On Nov. 12th it was completely overcast from 7 P.M. to 7.30 A.M.

On the 13th from 5 P.M. to 7 P.M. the amount of cloud was $\frac{1}{10}$, and only one meteor was seen. The sky was then obscure until near 1 A.M. of the morning of the 14th.

Nov. 14th, from 1 A.M. to 3.50 A.M., the amount of cloud was $\frac{1}{10}$ and four meteors were seen, two starting from near γ Leonis,

This was preceded by a hailstorm and rain, with occasional breaks in the clouds, through which we observed four meteors between 5 and 6.30 A.M.

On the evening of the 14th the sky was only half covered with clouds from 5 to 8 P.M., and eight meteors were observed between 5.48 and 6.40; one at 6.2 was of a brilliant red colour, with a pale greenish white train.

From 7.40 to 8.35 five other meteors were seen. The sky cleared for a short time towards 8 P.M., but at 9 a mist came on which obscured the heavens during the remainder of the night, clearing off, however, occasionally for a short time. I will not trouble you with the path of each separate meteor, though each was carefully noted. From the above observations I should be inclined to think that we had passed through the maximum during the afternoon of the 14th. Had there been any brilliant display during the night of the 14th, I think it would hardly have escaped me in spite of the mist.

Stonyhurst Observatory

S. J. PERRY

SPAIN AND THE ECLIPSE EXPEDITION

THE following is a translation of a letter which appears in the *Astronomische Nachrichten* for Nov. 15, on the facilities offered by the Spanish Government to such foreign astronomers as purpose visiting Spain on the occasion of the approaching eclipse:—

"MADRID, Nov. 5.

"I have the honour to inform you that the Spanish Government, at the request of the Observatory at Madrid, and in accordance with the resolution taken at the time of the eclipse of the sun in 1860, has just agreed that similar measures shall be adopted for facilitating to foreign astronomers the observation of the approaching solar eclipse on the 22nd of December of the present year. The Government has in consequence resolved,—

"That at the Spanish Custom Houses no duty or deposit shall be demanded on the astronomical or physical instruments that astronomers bring into Spain for the observation and study of the eclipse."

"But as this privilege, which has been granted with readiness to astronomers, might be taken advantage of by persons noways connected with Science, the Government has deemed it necessary to adopt certain measures of precaution, the principal one of which is, to be made cognisant of the names of the persons who are making preparations to come to Spain to observe the eclipse. In consequence thereof, the Minister of Finance has directed 'that such astronomers as purpose availing themselves of the resolution above spoken of should have the goodness to make known in writing to the Observatory at Madrid their names, the number and the class of instruments which they bring, and the point of the coast or frontier where they purpose entering Spain.' These particulars will be communicated by the Observatory to the Government, which will send orders to the Custom-houses to pass without difficulty all the instruments entered on the lists the astronomers furnish. Foreign astronomers may, moreover, reckon on the sedulous protection of the provincial governors and of the local authorities, from whom they will receive all the co-operation necessary to enable them to devote themselves with entire liberty to their scientific labours.

"In the Almanac of the Observatory of Madrid for 1870. (which you have not received owing to the want of communication with Germany for several months) there is contained a somewhat detailed account of the approaching eclipse, accompanied by two maps. As you will observe, in the zone of the total eclipse there have been inserted all the principal towns, in order to assist astronomers in the selection of their stations for observing. This central line is not of great dimensions in Spain (about sixty nautical miles) yet, nevertheless, there are numerous important towns in proximity to the central line, as, for instance, San Lucar, Jerez, Puerto de Santa Maria, Puerto Real, San Fernando, Cadiz, Medina Sidonia, Estepona, and at those places observers will meet with

all the resources requisite for carrying out their labours with facility. The sole disadvantage of so short a line is, that if the weather should prove unpropitious at one station, it will probably be so at the others as well.

"If you think any further details necessary, or in the case of any astronomer wishing to consult the map of the eclipse, nothing more will be necessary than to apply to the Director of the Observatory at Madrid, who tenders his services to such foreign astronomers as require them, and to whom it will afford great pleasure to aid his colleagues in bringing their scientific mission to Spain to a successful result.

ANTONIO AGUILAR"

THE CONSTRUCTION OF HEAVY ARTILLERY

IN few other manufactures has it been found necessary to search so deeply into the materials nature provides in order to find out the best and strongest, and then to apply it skilfully, so as fully to develop its strength, as in the manufacture of guns. The construction of the amazingly-powerful ordnance which modern naval warfare employs is pre-eminently a question of strength of material; indeed, it may be termed *the* question of strength of material. In nothing else does man employ forces even nearly so powerful and violent. The force of steam, even when doing its mightiest work, is but faint and small compared with that of the exploding charge of gunpowder that sends from the gun a 30lb. or 600lb. shot with a velocity which carries it through thick armour plates of wrought iron. A 600lb. shot will pierce twelve inches of iron at 200 yards distance. This gigantic force is imparted to the shot in the brief fraction of a second that it is moving down the barrel of the gun. Remembering that "the gain in power is loss in time," and consequently that when the time is diminished the power is proportionately increased, we may form some conception how enormously great is that force which is exerted within the breech of a heavy gun, and which is resisted by it every time it is fired. It is a force which, if turned into foot pounds, would represent the steam power not of a ship but of a navy. Yet all its work is to be done in the space of a few inches, and it must be surrounded with iron strong enough to resist it. Here we have the skill of man grappling with enormous difficulties, searching out the strongest and most suitable material that nature supplies, and exerting all his art to apply it to the utmost advantage. The construction of these exceedingly powerful guns has been entirely developed within the last few years. The gun now manufactured in Woolwich Arsenal is more unlike the gun of 1850 than the gun of 1850 is unlike that of Queen Elizabeth's reign. The progress of twenty years surpasses that of three centuries. And the change has not been so much in enlargement of size as in difference of construction. Queen Elizabeth's pocket-pistol is not more unlike a 600-pounder in external appearance than in internal structure. The gun which is carried in the turret of one of our ironclads, and which, at a single discharge, expends as great a weight of powder and shot as the whole broadside of a good-sized frigate of our own early days, does not surpass the gun which peeped from that frigate's ports so much in size and power as in the superior scientific principles of its manufacture. We propose in the present article to give a general view of these principles. The method of manufacture will be first explained, and afterwards the principles which guide the selection of the best material. Although the material must be selected before it is manufactured, yet a knowledge of the construction of a heavy gun, and of the qualities sought by construction to be developed, will very greatly facilitate our comprehension of the reasons of choice and preference among the many kinds of iron that might be and that are used.

In explaining the construction of modern ordnance as made for the British Government, it will be best to notice